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I, JONNE YABSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PS 3019 for a patent by SECURENCY PTY LIMITED as filed on 18 June 2002.

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Patents Act 1990

PROVISIONAL SPECIFICATION

Invention Title: **Polarising liquid crystal device for security documents**

The invention is described in the following statement:

POLARISING LIQUID CRYSTAL DEVICE FOR SECURITY DOCUMENTS

This invention relates to liquid crystal devices and is particularly concerned with polarising liquid crystal devices suitable for incorporation in security documents and methods for their manufacture.

The use of different forms of liquid crystals, both nematic and cholesteric, as security devices has previously been proposed. For example, US 5 602 661 discloses an optical component which has an orientation layer comprising a photo-orientable polymer network (PPN) in contact with a film of cross-linked nematic liquid crystal monomers with varying local orientation of the liquid crystal molecules. The liquid crystal monomers are oriented by interaction with the PPN layer and the orientation is fixed in a subsequent cross-linking step.

US 6160597 discloses an optical component comprising a stack of alternating PPN orientation layers and liquid crystal monomer (LCP) layers on a single substrate, the LCP layers being cross-linked to fix the orientation of the component.

The optical components of US 5 602 661 and US 6 160 597 have various uses, including liquid crystal cells in integrated optical devices, and as security devices for use as a safeguard against counterfeiting and copying.

It is possible to form images which are detectable when viewed under cross-polarizers using a photoalignment layer, such as the PPN orientation layers of US 5 602 661 and US 6 160 597, coupled with a nematic liquid crystal layer applied to its surface. However, this has previously required separate exposures to polarised light having different directions of polarisation and the use of a mask to cover different regions of the orientation layer during each exposure.

A disadvantage of the use of photo-alignment with a mask to form a latent image is that it is not possible to form a variable image which can be coded or personalised, such as a portrait of an individual.

US 5 678 863 discloses a means of identification or a document of value which has a cholesteric liquid crystal material applied to a watermark in a

transparent or translucent region so that the watermark changes colour under different viewing conditions. In order to form an image in a different colour, it is necessary to use two cholesteric liquid crystals which are chosen so as to produce alternatively right and left polarising light. A layer formed from such liquid crystals is quite thick and the liquid crystal materials are relatively expensive. Such a latent image is only circularly polarising in reflection and requires a circular polariser for viewing the colour changing effect.

It is therefore desirable to provide a polarising liquid crystal device which can be used to form variable latent images that can be readily incorporated in the production of security devices.

It is also desirable to provide relatively simple and effective methods of manufacturing such polarising liquid crystal devices for forming a latent image in a security document.

According to one aspect of the invention, there is provided a liquid crystal device comprising: a substrate; at least one photo-alignment layer applied to the substrate and which is uniformly aligned with a polarised light source; a nematic liquid crystal layer applied to the photo-alignment layer; and a latent image formed by the photo-alignment layer and the liquid crystal layer without the use of a mask, wherein the latent image is viewable under cross-polarisers.

Preferably, the at least one photo-alignment layer and/or the liquid crystal layer is applied to the substrate by a variable printing process, for example using ink jet printing or other variable printing technology which allows a variable latent image to be formed in the at least one photo-alignment layer and/or in the liquid crystal layer.

According to a second aspect of the invention, there is provided a method of manufacturing a liquid crystal device comprising:

Applying at least one photo-alignment layer to a substrate;

Uniformly polarising the photo-alignment layer with a polarised light source;

Applying a liquid crystal layer to the photo-alignment layer;

Wherein a latent image is formed in the at least one photo-alignment layer

and/or the liquid crystal layer by printing the image in at least one of said layers.

In a first embodiment, the latent image may be formed by applying the liquid crystal layer to a uniformly aligned photo-alignment layer only in a pattern representing the latent image. The photo-alignment area may be applied over the entire area of the substrate which forms the security device.

In another embodiment, the latent image may be formed by the photo-alignment layer which is printed on the substrate in a pattern representing the latent image. The liquid crystal layer can then be applied over the entire area of the device.

In a further embodiment, the latent image may be formed by a second photo-alignment layer which is applied to a uniformly aligned first photo-alignment layer covering the entire area of the device. The second alignment layer is applied, preferably by printing only, in a pattern representing the latent image, and is aligned with polarised light which is used to align the uniformly aligned first photo-alignment layer. The nematic liquid crystal layer may then be applied to the second photo-alignment layer, preferably also in the pattern representing the desired latent image.

In alternative embodiments, lasers may be used to write image areas and/or non-image areas in the at least one photo-alignment layer or in the liquid crystal layer.

According to a third aspect of the invention, there is provided a method of manufacturing a liquid crystal device comprising:

applying at least one photo-alignment layer to a substrate;

uniformly polarising the photo-alignment layer with a polarised light source;

applying a liquid crystal layer to the photo-alignment layer;

wherein a latent image is formed in the at least one photo-alignment layer and/or the liquid crystal layer by writing image areas or non-image areas in at least one of said layers.

In one embodiment of this aspect of the invention, a photoalignment layer is applied over the entire area of the substrate forming the device and is uniformly

aligned with polarised light. An ultraviolet (UV) laser is used to reverse the photo-aligned polarisation state either in areas which are to form the latent image or in non-image areas. Preferably, the UV laser has a wavelength of 280nm or less. The nematic liquid crystal can then be applied in a pattern representing the latent image.

In still further embodiments, a laser may be used to remove non-image areas of the uniformly aligned photo-alignment layer and/or the liquid crystal layer. The laser should be of sufficient strength so as to ablate non-image areas of the photo-alignment layer and/or the liquid crystal layer, rather than reversing the polymerisation state.

In each of the embodiments above, the liquid crystal layer may be fixed by a curing process, e.g. with UV radiation.

The polarising liquid crystal device may include further layers. For instance, in some embodiments a coating may be applied over the liquid crystal layer so as to provide a device of uniform height. Preferably, the coating has a refractive index which matches the refractive index of the liquid crystal layer to hide the latent image.

According to a further aspect of the invention, there is provided a security document incorporating a polarising liquid crystal device in accordance with the first aspect of the invention.

According to yet another aspect of the invention there is provided a polarising –liquid crystal device manufactured according to either the method of the second aspect or the method of the third aspect of the invention.

According to a still further aspect of the invention there is provided a security document incorporating a liquid crystal device manufactured in accordance with either the method of the second aspect or the method of the third aspect of the invention.

As used herein, the term "security documents or tokens" includes documents such as identity documents, value documents or entrance documents, which in turn respectively include: passports, visas, identity cards, drivers licences, and security ~~entrance~~ cards; banknotes, shares, bounds, certificates, cheques, lottery tickets, bank

cards, charge cards and credit cards; and aeroplane tickets, bus tickets, railroad tickets, and tickets to fun parks or specific rides.

The polarising liquid crystal devices of the present invention may be used to provide variable latent images of different forms in a wide variety of security documents. For example, a latent image in the form of a portrait of a cardholder may be provided in an identify card, a credit card or the like, so that the identity of the cardholder can be verified by viewing the latent image under cross-polarizers.

The present invention, which does not require separate exposures to polarised light using a mask, enables the latent image to be varied for different applications in a variable printing process and/or in a laser writing process.

Various embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is an enlarged sectional view of a first embodiment of a polarising liquid crystal device in accordance with the invention;

Figure 2 is a perspective view of a second embodiment of a polarising liquid crystal device in accordance with the invention;

Figure 3 is a sectional view of a third embodiment of a polarising liquid crystal device in accordance with the invention;

Figure 4 is a sectional view of a fourth embodiment of a polarising liquid crystal device in accordance with the present invention;

Figure 5 is a fifth embodiment of a polarising liquid crystal device in accordance with the invention;

Figure 6 is a sectional view through a sixth embodiment of a polarising liquid crystal device in accordance with the invention;

Figure 7 is a front view of a security document in the form of an identification card including a latent image formed by a polarising liquid crystal device in accordance with the invention;

Figure 8 is a front view of the security card of Figure 7 when viewed through cross-polarisers; and

Figure 9 is a front view of a flexible security document, such as a banknote,

including a latent image formed by a polarising liquid crystal device with an area of cross-polarisers incorporated into the security document for verifying the latent image.

The polarising liquid crystal device shown in Figure 1 comprises a substrate 10, an alignment layer 12, a nematic liquid crystal layer 14, and a refractive index matched coating 16.

The substrate preferably comprises a polymeric material, and more preferably comprises at least one bi-axially oriented polymeric film, such as described in WO 83/00659, the contents of which are incorporated herein by reference.

The alignment layer 12 is preferably a photo-alignment layer or orientation layer comprising a photo-orientable polymer network (PPN) of the type described in US 5,602,661 and US 6,160,597. The alignment layer 12 is applied to the substrate 10 to cover the entire area of the polarising liquid crystal device, preferably in a variable printing process, such as an ink jet printing process.

The nematic liquid crystal layer preferably comprises an anisotropic film of cross-linked liquid crystal monomers, such as described in US 5,602,661 and US 6,160,597 which is cross-linked to form a liquid crystal polymer (LCP) layer. In the embodiment of Figure 1, the nematic liquid crystal layer 14 is applied to an image area 18 of the device in a pattern representing the desired latent image. The liquid crystal is then fixed by using UV radiation or another appropriate method of curing. In order for the image to be truly latent, the liquid crystal layer 14 and the alignment layer 12 are covered by the refractive index matched coating to hide the height aspects which would otherwise be produced by the liquid crystal layer 14 forming the latent image.

In the embodiment of Figure 2, the alignment layer 12 is printed down on the substrate 10 only in the image area 18 in a pattern representing the latent image. The alignment layer 12 is uniformly aligned in the image area with a polarised light source. The nematic liquid crystal layer 14 is then applied over the entire area of the polarising liquid crystal device. The liquid crystal 14 is then fixed using UV

radiation or another appropriate method of curing. In this embodiment, because the liquid crystal layer 14 is applied over the entire area of the device, the refractive index matched coating 16 of Figure 1 may be omitted. However, in some applications a coating may be applied to cover the liquid crystal layer 14.

In the embodiment of Figure 3, a first photo-alignment layer 11 is applied to the substrate 10 covering the entire area of the device, and the layer 11 is uniformly aligned with a polarised light source. A second photo-alignment layer 12 is then printed on the first alignment layer 11 only in the image area 18 of the device in a pattern representing the latent image. The second layer 12 is aligned with polarised light at a different instant angle to the first. The nematic liquid crystal layer 14 is then applied to the second alignment layer 12 in the pattern representing the desired latent image. The liquid crystal is then fixed using UV radiation or another appropriate method of curing. As in Figure 1, a refractive index matched coating may be applied over the liquid crystal layer 14 to cover the entire area of the device to hide the height aspect otherwise produced by the layers 12 and 14.

Referring to Figure 4, a photo-alignment layer 41 is applied to the substrate 40 to cover the entire area of the device. The layer 41 is uniformly aligned with a polarised light source. A UV laser, having a wave length of 280 nm or less is then used to "write" the non-image areas 42 into the alignment layer 41. The exposure to wave lengths of 280 nm or less can be used to reverse the photo-aligned polymerization of the alignment layer 41 in the area 42, leaving an image area 43 of the alignment layer 41 in the image area 48 of the device. The UV laser radiation is represented by arrows 45 in Figure 4. The nematic liquid crystal layer 44 is then applied to the image area 48 in the pattern representing the desired latent image. The liquid crystal is then fixed using UV radiation or another appropriate method of curing. If the image is to be truly latent a refractive index matched coating 46 can be applied to hide the height aspect produced by the liquid crystal layer 44.

In Figure 5, a photo-alignment layer 51 is applied to the substrate 50 covering the entire area of the device. The alignment layer 51 is uniformly aligned with a polarised light source. A laser is then used to remove non-image areas of the

device outside the image area 58 by ablating non-image areas 52 leaving a non-ablated image area 53 of the alignment layer 51 in the image area 58 of the device. The laser ablation is represented by arrows 57. The nematic liquid crystal layer 54 is then applied to the non-ablated image area 53 of alignment layer 51 in the pattern representing the desired latent image. The liquid crystal is then fixed using UV radiation or another appropriate method of curing. As in Figure 4, if the image is to be truly latent a refractive index matched coating 56 is applied over the liquid crystal layer 54 to cover the entire area of the device.

Laser ablation is used in a different manner to form the latent image in Figure 6. In this embodiment, the photo-alignment layer is applied to the substrate 60 covering the entire area of the device. The layer 61 is uniformly aligned with a polarised light source. A liquid crystal layer 64 is then applied on the alignment layer 61 to cover the entire area of the device. A laser 67 is then used to ablate non-image areas 62 of the liquid crystal layer 64, leaving a non-ablated image area 63 of the liquid crystal layer 64 in the image area 68 of the device. As in Figures 4 and 5, a refractive index matched coating may be applied over the liquid crystal layer 64 in order to hide any height differences caused by the laser ablation of the liquid crystal layer 64.

In addition to this it is possible to print a uniform photoalignment layer and then align it all one direction. A polarised UV, scanning laser is then used to destroy alignment in particular areas of the photoalignment layer so as to produce an image in the photo alignment layer. To this, a nematic liquid crystal is applied.

Figure 7 shows a security document in the form of an identity card 70 which includes a polarising liquid crystal device 76 which may be formed by any of the methods described with reference to Figures 1 to 6.

The identity card 70 is printed with indicia over the entire card except in the area of a transparent window 74 in which the LC device 76 is provided. The image area 78 of the LC device 76 is shown in broken lines in Figure 7 in the form of a portrait of a person. The non-image area 79 of the device forms a background for the portrait 78.

Under normal viewing conditions, the portrait 78 formed by the latent image of the liquid crystal device 76 is barely discernible. However, when the polarising liquid crystal device is viewed under cross-polarisers, the portrait 78 formed by the latent image of the liquid crystal device 76 becomes plainly visible. Thus, if the portrait 78 corresponds to the cardholder of the identity card 70, the correct identity of the cardholder can be verified by viewing the latent image of the liquid crystal device 76 under cross-polarisers.

A further use of polarising liquid crystal devices in accordance with the invention is illustrated by Figure 9 which shows a security document in the form of a single flexible sheet, such as a banknote 90. The banknote 90 includes a latent image formed by a polarising liquid crystal device 96 provided in a transparent window 94 of the banknote. The latent image formed by an image area 98 of the liquid crystal device 96 is shown in the form of a portrait of a person. However, in this application the latent image may take a variety of different forms.

The flexible security document or banknote 90 is printed with indicia 92 covering the entire area of the banknote 90 except in the area of the transparent window 94 and a further transparent window 95 which includes cross-polarisers. The cross-polarisers in window 95 may be used to reveal the latent image 98 in window 94 by folding the flexible security document so that the window 95 overlies the window 94, thereby verifying the banknote.

The present invention therefore provides a polarising liquid crystal device forming a latent image which can be incorporated into a wide variety of security documents for verifying the authenticity of the security documents. The polarising liquid crystal devices can be readily manufactured using conventional variable printing technology, so that it is relatively simple to modify the latent image during manufacture to enable a wide variety of latent images to be produced for use as security devices in security documents.

It will be appreciated that various modifications may be made to the preferred embodiments described above with reference to the drawings without

departing from the scope and spirit of the present invention.

DATED: 18 JUNE 2002

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SECURENCY PTY LIMITED

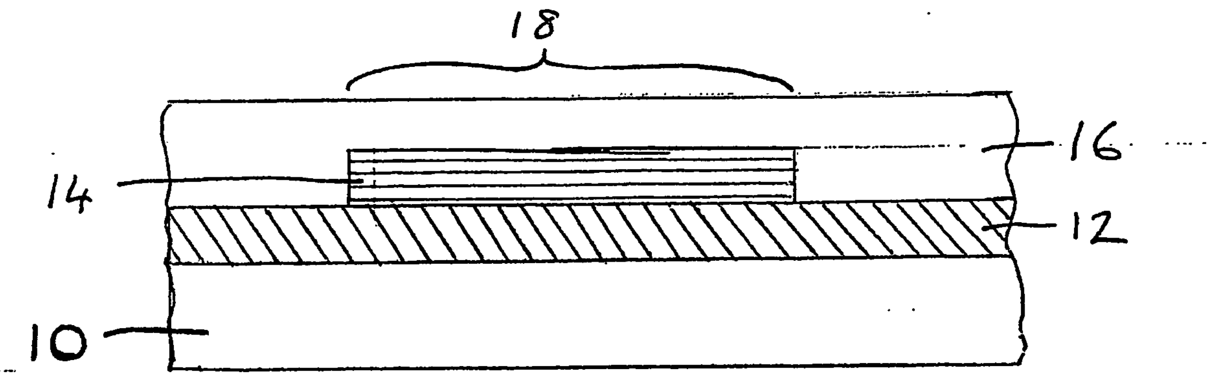

FIG. 1

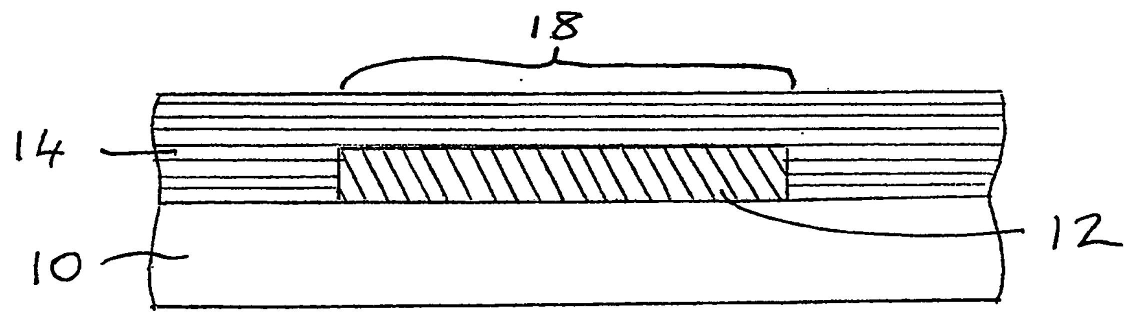

FIG. 2

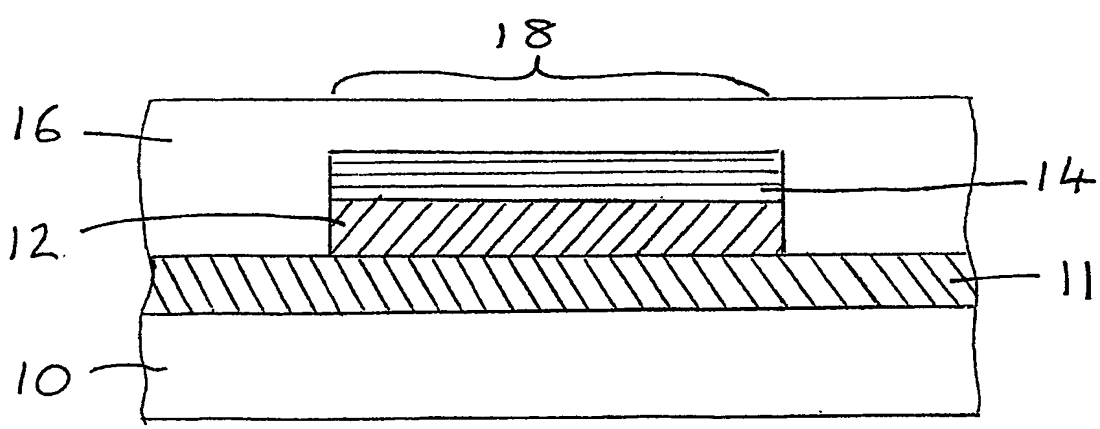

FIG. 3

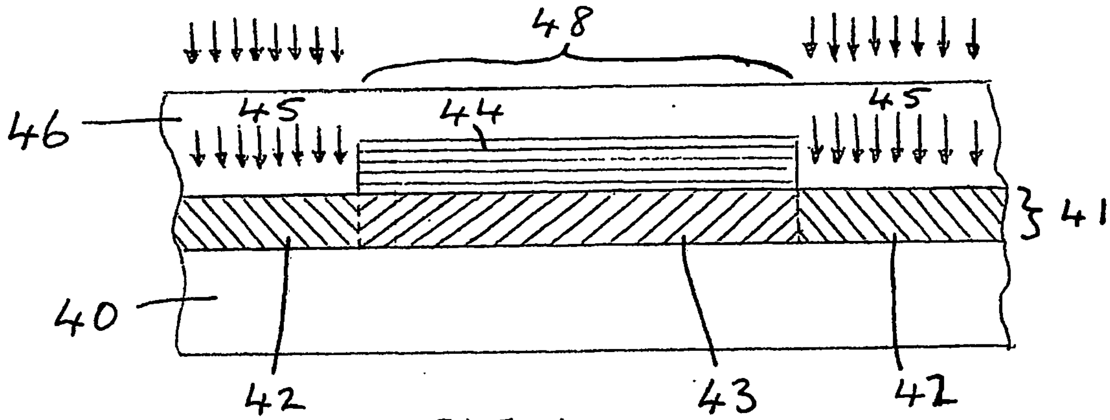

FIG. 4

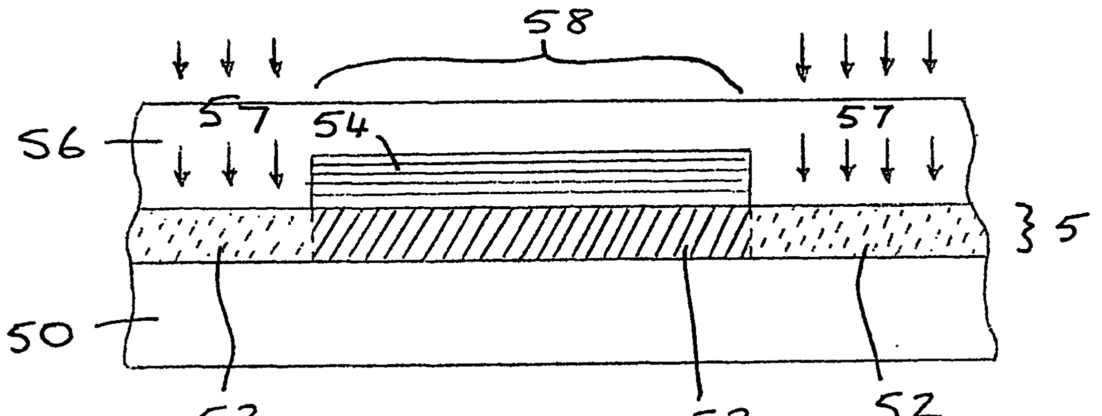

FIG. 5

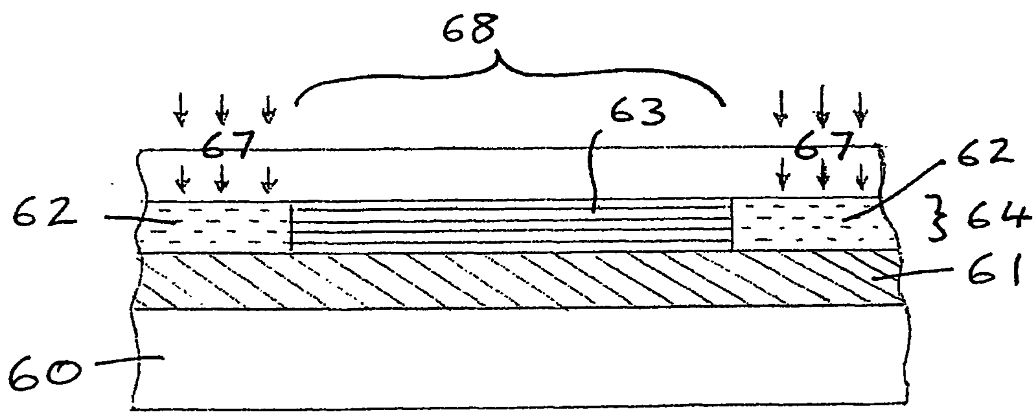

FIG. 6

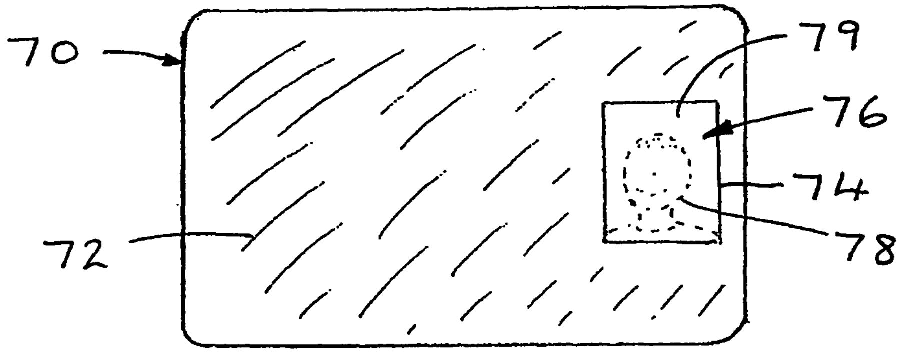

FIG. 7

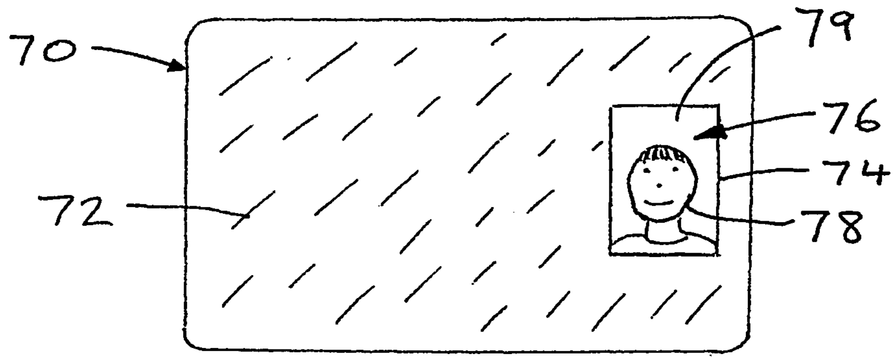

FIG. 8

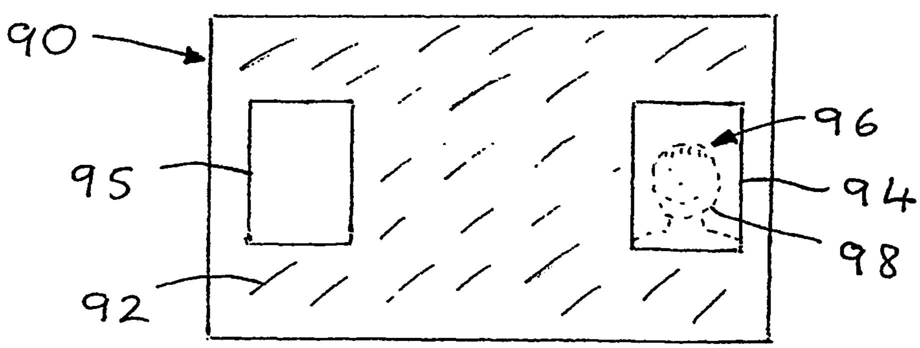

FIG. 9